Credit-based Payments for Ecosystem Services: Evidence from a choice experiment in Ecuador

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Abstract

The classical conceptualisation of PES promoted direct payments as the most efficient form of incentivising good environmental behaviour, but both that PES conceptualisation and the acceptance of direct payments as always being the best option have recently been questioned. Depending on the specific market and social conditions, indirect PES may be preferred. Improving access to affordable credit is one such form of indirect PES that is particularly relevant for PES in developing countries. The main issue with such an approach is how to include conditionality. There are very few examples, but credit-based PES (CB-PES) is one such mechanism. A choice experiment was carried out in Northern Ecuador to explore the dynamics of CB-PES, illuminate lessons for its implementation, and comment on its appropriateness as an incentive. It was found to be a promising form of PES that fits multiple criteria recently noted in the PES literature as desirable qualities of an incentive.

Key Words

Payments for ecosystem services, microcredit, agroforestry, choice experiment, Ecuador

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1. Introduction

There are various formal definitions of payments for ecosystem services (Muradian et al., 2010; Sommerville et al., 2009; Tacconi, 2012; Wunder, 2005), but they all generally describe PES as positive and (at least somewhat) conditional incentives provided to induce a preferred environmental behaviour. Since the rise in popularity over the past two decades of using PES to pay for regulating and cultural ecosystem services (ES), PES schemes have proliferated globally. For example, there are over 200 active payments for watershed services (PWS) schemes in over 20 countries (Watershed Connect, 2012) and at least 412 forest carbon projects in 49 countries (Diaz, Hamilton, & Johnson, 2011).

Following such proliferation, PES programmes are now found in many diverse contexts giving rise to a spectrum of PES schemes that don't all follow the original concept of PES as a Coaseian transaction (Muradian et al., 2010). As part of that original conceptualisation, it was generally believed that direct, output-based payments were always the most efficient form of incentive and would always be preferred by the principal that is demanding ecosystem services ES (Ferraro & Simpson, 2002). Such demand-side interventions, however, are only effective if the proposed suppliers of ES have the ability to do so. Where market constraints exist, indirect, supply-side incentives may be more efficient and preferred by both the agent and the principal (Groom & Palmer, 2010).

Various market constraints are common in least developed and emerging economies, where many PES schemes are found and where PES are likely to proliferate further in the future through, for example, resource mobilisation plans by parties to the UN Convention on Biological Diversity, a REDD+ mechanism under the UN Framework Convention on Climate Change, and related concepts and initiatives such as green growth. In particular, credit constraints still exist in many places and are a key constraint for the production of ES. Although systematic evidence of the effect of credit constraints on the uptake of activities being incentivised by PES is lacking, many cases clearly demonstrate the phenomenon. For example, in Ecuador, PROFAFOR provides 80% of its PES incentive up-front to support the inputs to the reforestation process, with only 20% of the incentive provided after reforestation is deemed successful (Wunder & Albán, 2008). Many PES schemes attempt to incentive changes in land use on productive land, specifically interventions that fall under the broad umbrella of agroforestry. Cases demonstrate that credit constraints can be a significant constraint to the uptake of agroforestry generally (Pattanayak et al., 2003) and in a PES context specifically (Pagiola et al., 2007).

In addition to economic constraints, current PES discourse continues to reference research from behavioural sciences on what makes a good incentive (Farley & Costanza, 2010; Muradian et al., 2010; Sommerville et al., 2009; Vatn, 2010). A key result from that behavioural research is that extrinsic incentives work better if they are considered *supportive* rather than *controlling* (Frey & Jegen, 2001), a pre-condition that indirect, or specifically credit-based PES, intuitively seems to fit. Further, credit-based incentives are believed a clear mechanism through which to link both poverty alleviation and environmental objectives (Groom & Palmer, 2010).

The key concern with any indirect incentive, however, is that they historically have not been *conditional* incentives and so do not ensure that conservation will occur (Wunder, 2005). Thus the key innovation that is required is to incorporate ES conditionality into indirect incentives, particularly into credit provision.

We carried out a choice experiment in Ecuador to explore the possible dynamics of such an approach: credit-based PES (CB-PES). The next section reviews the state of credit provision and conservation activities in more depth. The following sections in turn describe the case study carried out, explain the analysis and results of that study, and discuss the implications for the concept of CB-PES more broadly. The final section concludes.

2. Credit and conservation

The primary focus of research and work on how credit provision and natural resource management (NRM) overlap has been on either the mechanisms through which classical finance, specifically microfinance, can affect NRM (Anderson et al., 2002) or how microfinance can be used to directly finance specific conservation-friendly activities (e.g. Wild et al., 2008). More recently, there have also been advancements in how to create some form of conditional link between credit provision and environmental behaviour. As such, there are now three primary ways that the provision of microcredit can be linked to the conservation of nature.

The first is selective lending, where credit is only provided to finance activities that should themselves have a positive impact on the provision of biodiversity or ES, or at least not have a negative impact (i.e. finance alternative livelihoods). Such selective lending can occur at the household or community level (Wild et al., 2008) or at the level of somewhat larger enterprises. For example, many funds exist that selectively finance biodiversity-friendly businesses[1].

The second is where access to credit is conditional on good environmental behaviour. Where this occurs on a contract basis, borrowers either can not borrow unless they *ex-ante* meet certain environmental best practices (Anderson et al., 2002) or must have met environmental covenants on previous loans. Such a link has also been proposed at the fund level (Mandel et al., 2009), where a community development fund would be capitalised to an amount that is correlated to the value of natural capital that the community is charged to protect. If the natural capital degrades, thus losing value, the size of the community fund will be decreased, thus meaning fewer funds are available for borrowing. Essentially, the natural resources of interest are considered collateral against the value of the fund, which is why this approach has been called an environmental mortgage[2].

The third way that microcredit can be linked to environmental behaviour is to include an environmental condition in the loan contract, where the amount of the repayment that needs to be made is conditional on a certain environmental behaviour being carried out (Table 1). The examples that exist fall on either end of a spectrum of conditionality. At zero conditionality, some microfinance institutions include requirements for environmental actions in their contract (e.g. plant a tree) (Anderson et al., 2002), but if that condition is not met, there is no immediate reward or punishment.

Table 1. Conceptualising credit-based PES (CB-PES)

Proportion of periodic repayment "forgiven" if condition is met	100% ⟷		0%
Credit vs. PES	Convertible: Credit or PES	Credit/PES blend	Credit only, no PES
Maximum Loan Size	Constrained to amount ES buyer is willing to pay	Dependent on proportion of credit that is conditional and amount ES buyer is willing to pay	No constraint from value of ES
Example	Wetlands International	No known examples	Grameen

At the complete opposite end of the conditionality spectrum, if a contractual environmental condition is met, the loan does not have to be repaid at all and is essentially converted to PES (van Eijk & Kumar, 2009). If the condition is not met, however, the loan must be repaid as normal. Between these two ends of the spectrum lie possible mechanisms where credit is

[1] e.g. Proyecto CAMBIO, Verde Ventures, Eco-enterprises Fund
[2] The concept was developed by Advanced Conservation Strategies and CSIRO, and is being piloted in the Asia-Pacific region. More information at www.advancedconservation.org/environmental-mortgages/

borrowed and if an environmental condition is met, a portion of the loan is forgiven and the amount that must be repaid is lowered. That is what we call credit-based payments for ecosystem services (CB-PES). To the best of our knowledge, only convertible (i.e. 100% conditional) loans have been implemented, and these projects have been reported as highly successful[3].

3. A choice experiment of CB-PES in Ecuador

As discussed so far, for both economic and behavioural reasons, CB-PES could be a desirable incentive in various contexts, but particularly in developing countries. Although some circumstantial and anecdotal evidence exists to support that claim, significant empirical work and piloting is needed to validate it. In that vain, a stated preference study was carried out in Northern Ecuador. Through implementing a choice experiment among local households, the study aimed to 1) better understand the potential dynamics of CB-PES, and 2) make some comment on CB-PES as an incentive mechanism.

3.1. The Intag River Zone of Ecuador

Located just north of Quito, the Intag River Zone of Ecuador covers approximately 150,000 hectares (ha) with an estimated population of 17,000 people living in 90 communities (Kocian et al., 2011). The zone is a highlands area, with steep peaks surrounding streams and a central river valley. Intag ranges from sub-tropical forest to páramo, over an altitude of around 1500-4000 meters above sea level, and is characterized by various forms of cloud forest covering 44,000 ha (Energia Hidro Intag, 2009).

Intag falls within the influence of two global biodiversity hotspots: Tropical Andes and Tumbes-Choco-Magdalena (Myers et al., 2000). The zone is home to a large diversity of flora and fauna including 11,000 plant species, of which 25% are endemic, and more than 900 bird species, of which 77 are unique to this bioregion (Energia Hidro Intag, 2009). A number of the species found in the area are of vulnerable and endangered taxa, for example, the 160 mammal species in the region includes the spectacled bear. The ecological threat to this area is evidenced by the status of the spectacled bear (an umbrella species) as vulnerable throughout its range, but endangered in Ecuador (Cuesta et al., 2003) in large part due to habitat fragmentation.

The loss of cloud forests is directly detrimental to society as they are a source of ecosystem services that are beneficial on a local, regional and global scale. Cloud forests are particularly valuable for their high level of biodiversity and regulation of water quality and supply (Bubb et al., 2004), both of which provide tangible benefits in Intag. Ecotourism in Intag directly injects a minimum of US$66,420-177,120 into the local economy, but is likely worth at least that amount again in indirect benefits (Kocian et al., 2011). While the water regulating

[3] The concept was developed by Wetlands International and implemented in Southeast Asia. More information at www.wetlands.org/biorights or page 147 of (Parker et al., 2012)

services provided by the cloud forest not only support local agriculture, but the Intag River flows into and accounts for approximately 30% of the flow of the Guayllabamba River (Energia Hidro Intag, 2009), which in-turn flows into the Esmeraldas River and helps to fuel large-scale agriculture in the province of Esmeraldas.

The greatest threat to cloud forests throughout the world is agricultural conversion. In Latin America 90% of cloud forests are threatened by agriculture (Bubb et al., 2004) and specifically in the Ecuadorian Andes deforestation is predominantly due to the demand for agricultural land and cattle ranching (Wunder, 1996). While in some cloud forest regions throughout the world, traditional land-use systems with features that ensure sustainability have been maintained, this is not the case in Intag. The majority of the population in Intag is composed of settler families that moved to the region in the early-1900's, bringing unsustainable agricultural practices with them.

Together, agriculture, timber collection, and grazing have led to large-scale deforestation across Intag that still continues today. With much of the forest already removed, the average annual deforestation rate from 2001 to 2006 was 1.92% in Cotacachi County (Intag covers 75% of this county) and 2.47% across the entire Imbabura province in which Intag sits (Peck, 2009). Both are greater than the annual average rate of deforestation of 1.7% observed across all of Ecuador during that same time period (FAO, 2009).

Although significant efforts to curb deforestation and increase forest cover have been implemented in Intag in the last decade, more work is needed to not only improve the status of cloud forests in the area, but also improve the sustainability of agricultural land. An increase in area under agroforestry would decrease pressures on forests, while also improving the biodiversity and ecosystem service benefits from agricultural land in the region. These changes are needed to protect biodiversity and a suite of ecosystem services that benefit local communities. The most salient concern, however, is that the impacts of climate change are predicted to increase annual rainfall in the zone[4]. The past and current practices of monocropping and forest conversion have left a highland landscape with much less forest cover than is natural. Without improved land-use practices, increases in rainfall will increase runoff, reducing the productivity of farmland and increasing siltation in waterways, with severe implications for climate change adaptation.

Households in Intag have increasingly practiced sustainable agriculture since 1998 with the establishment of the Asociación Agroartesanal de Caficultores "Rio Intag" (AACRI). The project was started by a local NGO, Defensa y Conservación Ecologica de Intag (DECOIN), with 18 participating farms. As of around 2010, 400 farms were members of AACRI, which has grown into an independent business, selling coffee at multiple locations in Ecuador and

[4] As indicated by the climate scenarios in 'Proyecto de Adaptacion al Cambio Climatico a traves de una Efectiva Gobernabilidad del Agua,' http://www.pacc-ecuador.org/

exporting to Europe and Japan. In addition to shade-grown coffee, agroforestry in general is receiving greater attention in the region. A UK-based NGO, Rainforest Concern, is carrying out a conservation project in the region to develop the Choco-Andean Corridor. The largest extension of forest within the southern portion of the corridor is 5,000 hectares known as Paso Alto. A management plan for Paso Alto was developed by Rainforest Concern, AACRI, and ALLPA (a partner organization to AACRI), and agreed with the Ecuadorian Ministry of the Environment in 2006. Promoting sustainable agricultural practices is a significant part of that management plan. Since the agreement, 41 farms have converted a one-hectare parcel of their land to agroforestry (mainly shade-grown coffee), with the aim that they will soon see the benefits and work to convert further land to more sustainable practices. These farms are in the Selva Alegre Parish of Intag where deforestation rates mirrored the county average of 1.92% annually from 2001 to 2006 (Peck, 2009), so alleviation of pressure on forests is clearly vital for successful conservation of Paso Alto. To date, however, much of the support for agroforesty practices has been grant-based. Further, agroforestry is still only practiced by a minority of households, and only on a small fraction of land of the households that do practice it.

The Intag River Zone is an appropriate case study for the potential of CB-PES for two reasons. First, it is a good representation of the Andean context. Intag ranges from 1,400 to 4,000 meters and so the range of ecosystems and production systems seen across the Andes are represented in Intag. Second, Intag meets the theoretical economic preconditions for CB-PES to be of interest. It is remote and the terrain is tough, meaning it is very difficult to get supplies in and goods out, so market constraints exist, and that includes credit constraints. Although households in the region are familiar with credit, it is not readily available in the region and local agricultural specialists believe that to be constraining uptake of eco-friendly production systems (Arisman, 2012). As predicted by Groom and Palmer (2010), with these market constraints in place, the conservation principals (i.e. organisations that have funded conservation activities in the region in the past) are becoming interested in the potential for linking credit provision and conservation activities.

3.2. Methodology

A survey of 347 households in approximately 50 different locations[5] was carried out from August through mid-October, 2010. The sample was collected by local extension workers, which due to very difficult terrain could only be done through opportunistic sampling, but with some guidance. Extension workers focused on communities situated on the south-eastern side of the Intag River, so lying between the river and the Choco-Andean corridor project, an effort to link multiple smaller ecological reserves south of Intag to the large Cotacatchi-Cayapas ecological reserve (Figure 1). Since some of the communities in this part of Intag have been engaged in shade-grown coffee or the specific pilot scheme to promote

[5] The idea of a "community" is difficult to define in the region, so location refers to collection of houses in a named portion of the zone.

agroforestry as part of the Paso Alto management plan, the extension workers' aim was to collect a sample of households with a range of agroforestry experience. The extension workers also strived to collect surveys across a range of altitudes to collect a diversity of ecosystem contexts and farm compositions that represented the zone and the Andes more broadly.

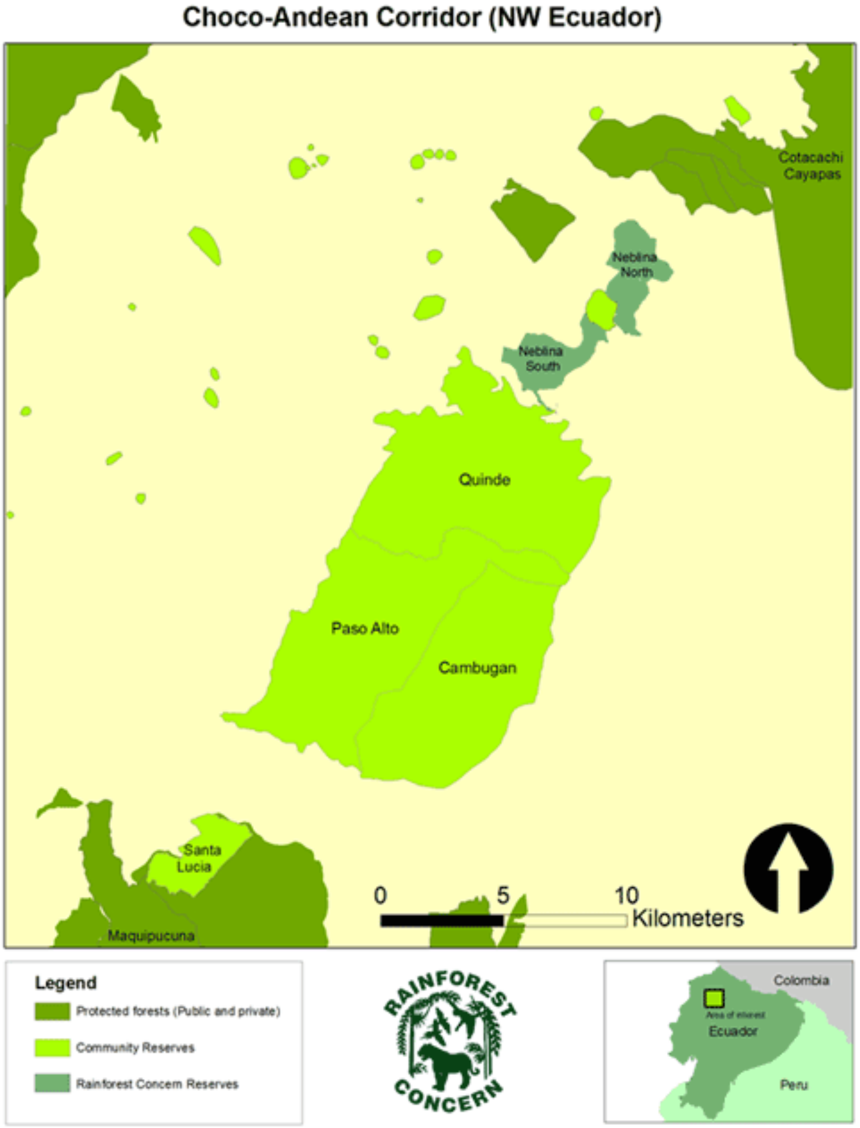

Figure 1. The Choco-Andean Corridor Project (provided by Rainforest Concern)

The main body of the survey collected information about each household's social characteristics, land ownership and use, crop production, livestock rearing, forest-related activities, and non-farm income. The final portion of the survey collected information on their experience with and views towards agroforestry, which was followed by a choice experiment.

The choice experiment was designed to determine a household's preferences for loans with and without an environmental condition. The four attributes (Table 2) were thus loan size (in US $), maturity (years), conditionality (a binary attribute), and annual interest rate (%). To reduce cognitive burden, the average annual payment associated with the loan was listed along with the interest rate. A fractional factorial orthogonal design of 16 choice sets was determined and pairs were defined using a shifting technique. Although shifting is often not viewed as the optimal method in choice experiment design, it was deemed appropriate here due to the relatively small sample size and lack of a-priori information on parameter values (Ferrini & Scarpa, 2007).

Table 2. Attributes and levels for choice experiment in Intag agroforestry survey.

Attribute	Levels
Loan	$1000, $2500, $5000
Maturity (i.e. payback period)	Short (1-2 years), Medium (3-5 years), Long (6-10 years)
Conditionality	Have to convert one hectare of land to agroforestry, or not
Interest (percentage per year)	0%, 5%, 12%, 18%

In this choice experiment, the hypothetical situation presented was as realistic as possible and involved a conversation between the survey implementer and respondent that covered these key points:

- An organisation could provide credit to some families in your community
- Credit could be borrowed for any purpose
- The organisation would like to see an increase in agroforestry
- Some of the loans may have a lower interest rate and a condition that you must convert one hectare of your land to agroforestry
- That lower interest rate, however, is only available if you are able to meet the condition
- If you do not meet the condition, you will have to pay back the loan at normal interest rates (which are 12-18% in surrounding areas).

Each respondent was presented with four choice cards. Each included an unconditional loan, a conditional loan, and the option to not take any loan (a status quo option).

A nested logistic (nlogit) model was estimated using Biogeme (Bierlaire, 2003, n.d.), where the dependent variable was whether or not a loan was chosen. A nested logit model was chosen because of the three alternatives on each choice card, the unconditional loan and the conditional loan shared some unobserved attributes that were similar (because they were both loans) and so violated the assumption of independently distributed error. Further, because each respondent was given four choice cards to answer, there was correlation between each response provided by a give respondent. To account for that correlation a random, respondent-specific effect was included at the level of the nest. That effect was intended to account for the unobserved characteristics of a respondent that could influence the likelihood they would accept a loan of any sort (whether it was conditional or not). The utility function to conceptualise the model is shown below.

$$U_{a,i} = \underbrace{V_{a,i}}_{\text{Systematic Utility}} + \underbrace{\varepsilon_{a,n,i}}_{\text{Alt.-specific Error}} + \overbrace{\sigma_{n,i} + \varepsilon^{/}_{n,i,t}}^{\text{Nest-specific Error}} \; , \quad a \in C_{i,t}$$

a = alternative
i = individual
n = nest
t = “time”

4. Results

4.1. Descriptive Statistics

The survey implementers were instructed to try and speak with male heads of households, who have most say over household and land use decisions. The average respondent was male (94%), 49 years old, and with a little more than 5 years of education, corresponding to primary school in Ecuador. They were the head of a household of 2.4 adults and 1.4 children (<18 years of age).

On average, households claimed some sort of tenure of 14.7 hectares of land, 3.6 of which was set aside for cultivation and 5.6 of which was actively used for pastureland. Most households (63%) claimed legal title to at least a portion of their land, although legal title is difficult to prove in the zone. The mean annual gross cash income for 2010 was $6,754, which was dominated by crop income (56% of total income). The mean is skewed by a few notable richer farmers in the area, and the median income was $4,000 and 56% of families lived below the $2 poverty line[6].

In relation to agroforesty, 63% of respondents said they understood what agroforestry was before an explanation was given. After that explanation, 90% of respondents reported preferring agroforestry to traditional agriculture and 57% stated an economic reason why they believed agroforestry was better. The primary reason given was that agroforestry incorporates a diversity of crops that helps smooth production and income over the year. All households believed agroforestry to be more environmentally friendly. On average, each household currently has 1.4 hectares of land under a use that could be considered agroforesty (although that amount varies widely), but if lending was available and affordable, they would on average like to convert an additional 2.9 hectares, with the greatest demand for silvopasture (1.7 ha).

4.2. Choice Model

The model shows that choosing an alternative was explained by the four attributes of the loan alternatives presented and an alternative specific constant for the “no loan” option, plus some

[6] i.e. $2 per person per day converted by national purchasing power parity

interactions between the loan attributes and select socioeconomic characteristics of respondents (Table 3 and Table 4).

Table 3. Variables included in the nlogit models of loan choice. Loan attributes are in all capital letters, the sample average for loan attributes are based on chosen loans only.

Explanatory Variable	**Description** (units)	**Mean for Chosen Alternative** [min,max]
AMOUNT	Size of loan (US$)	$2,286 [0,5000]
MATURITY	Payback period of loan (years)	3.6 [0,8]
CONDITION	If agroforesty condition applied (binary)	0.39 [0,1]
RATE	Annual interest rate (%)	3.7% [0%,18%]
NO LOAN	Alternative specific constant for "no loan" (binary)	0.17 [0,1]
Max Liability	Whether or not the loan size of a given alternative is lower than the respondent's household's annual gross cash income (binary, 1 if income > loan size)	0.75 [0,1]
Own Land	Whether or not household claims title to some land (binary)	0.63 [0,1]
Crop Value	Monetary value of crops produced in 2010 ($)	$2,755 [0, 43934]
# Children	Number of children in household (#)	1.4 [0, 7]

Model 1 includes the loan attributes only and the alternative specific constants for the "no loan" option. Model 2 was built using a blocking approach of interactions of loan attributes with socioeconomic characteristics. Few interactions were found to have a statistically significant association with whether or not a loan was chosen and those maintained in Model 2 are the interactions whose statistical significance was robust throughout the blocking approach. The fit of Model 2 is a statistically better fit than Model 1 based on a log-likelihood ratio test and so is preferred.

Table 4. Nested logistic model of loan choice with a random respondent-specific effect (100 draws).

		Model 1		**Model 2**	
Parameter		*Coefficient (S.E.)*		*Coefficient (S.E.)*	
β AMOUNT		.240 (.057)	***	.168 (.056)	***
β Ln(MATURITY)		.553 (.127)	***	.849 (.169)	***
β CONDITION		-.243 (.140)	(*)	-1.090 (.365)	***
β RATE		-.290 (.029)	***	-.288 (.029)	***
β NO LOAN		-2.156 (.299)	***	-1.569 (.302)	***
β AMOUNT (/1000)	* Max Liability			.270 (.065)	***
β Ln(MATURITY)	* Own Land			-.529 (.166)	***
β CONDITION	* Ln(Crop Value)			.134 (.051)	**
β NO LOAN	* # Children			-.352 (.098)	***
μ (Nest parameter)		0.671 (.085)	***	.703 (.088)	***
σ (Random effect parameter)		1.229 (.222)	***	-1.170 (.235)	***
Log likelihood		**-679**		**-654**	
Pseudo R^2		**0.355**		**0.375**	
Observations		**969**		**969**	
Respondents		**315**		**315**	

(*) p<0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

Loan size has a positive associate with the choice of alternative, indicating that a larger loan is preferable, likely because there is a positive association with having more money available, specifically in the case of a loan that means more investment capital. The positive association with size of loan is mediated by an interaction with the respondent characteristic of "max liability", which indicates whether or not the chosen alternative has a loan amount that is greater than the annual gross cash income of the respondent's household. This measure is chosen because in microfinance economics, it is the theoretical maximum liability that would be imposed on a household or accepted by a microfinance institution (MFI) (Armendáriz & Morduch, 2005). The ability of a respondent to repay depends more precisely on their ability to meet annual repayments, but this nonetheless indicates some sort of budget consideration is included in the respondents' choices.

Longer maturity also has a positive association with choice, which is intuitively sensible since a longer maturity lowers annual loan repayment and allows a longer time for repayment. Importantly, the natural logarithmic transformation of the maturity attribute was statistically more significant that the linear function or any other transformation. That natural log transformation results in a yield curve that is normal and upward sloping, mimicking the standard credit yield curve seen in debt markets the world over. Further, the preference for longer maturity seems reversed to some degree by a household holding title over their land, which indicates that security in land tenure leads to increased financial security, or at least respondents believed this to be the case.

As would be expected, interest rate has a negative association with loan choice, meaning respondents prefer cheaper loans. The alternative-specific constant for the no loan option also has a negative association with loan choice indicating that respondents generally would like to borrow. The number of children in a household mediates that association. The more children a household had, the more they preferred a loan to the no loan alternative. That is likely because these households have a future to invest in and more hands that can work to help ensure the loan could be repaid. It should also be noted that respondents that chose loans, tended to choose loans for all of their four choice cards, which would inflate the observed preference for loans. Including the random, respondent-specific effect at the level of the loan nest helped mitigate this.

Finally, the environmental condition on the loan has a negative association with choice of an alternative. Importantly, this effect is mediated to a large degree by the total value of crops a household reported producing in a year. That large effect is indicated by the drastic change in magnitude of the condition main effect between Models 1 and 2, the latter of which introduces the interaction with crop value. Crop value was introduced as a proxy for the loss or gain a household would receive from carrying out the environmental condition. In this case, crop value is a complex variable that includes information about factors such as amount of land, productivity of land, availability of inputs to production, a household's knowledge of and ability to farm, and the market price that could be fetched for crops. Where crop value is low, these underlying variables are likely to be smaller, indicating a greater opportunity cost and a lower chance of profiting from the environmental condition, in this case, converting land to agroforestry. But where crop value is high it indicates that the household has land available to convert, so a low opportunity cost, and/or a larger chance of successful agroforestry, so a larger expected gain from carrying out the condition.

The fact that the coefficient for the crop value interaction is the least significant coefficient of the entire model indicates that it is indeed a proxy for the true variable of interest: the expected loss or gain of meeting the environmental condition. Nonetheless, it is still highly significant and so a good predictor. That result is intuitive, but important to have empirically shown: that the uptake of CB-PES will depend on a household's predicted cost or gain associated with the environmental condition proposed.

4.3. Welfare Change Associated with Environmental Conditionality

The choice experiment method is consistent with utility maximization and demand theory (Bateman et al., 2003), so when the parameter estimates of the model are obtained, welfare measures can be obtained. In stated preference studies, this is done by estimating the marginal substitution between the change in an attribute and the utility of a monetary value, which in choice experiments is usually a willingness-to-pay or willingness-to-accept attribute (Hoyos, 2010). Here, the same approach is applied to measure the welfare change associated with the attribute of the environmental condition applied, but to measure in more tangible terms as a change in annual interest rate of a loan (Figure 2).

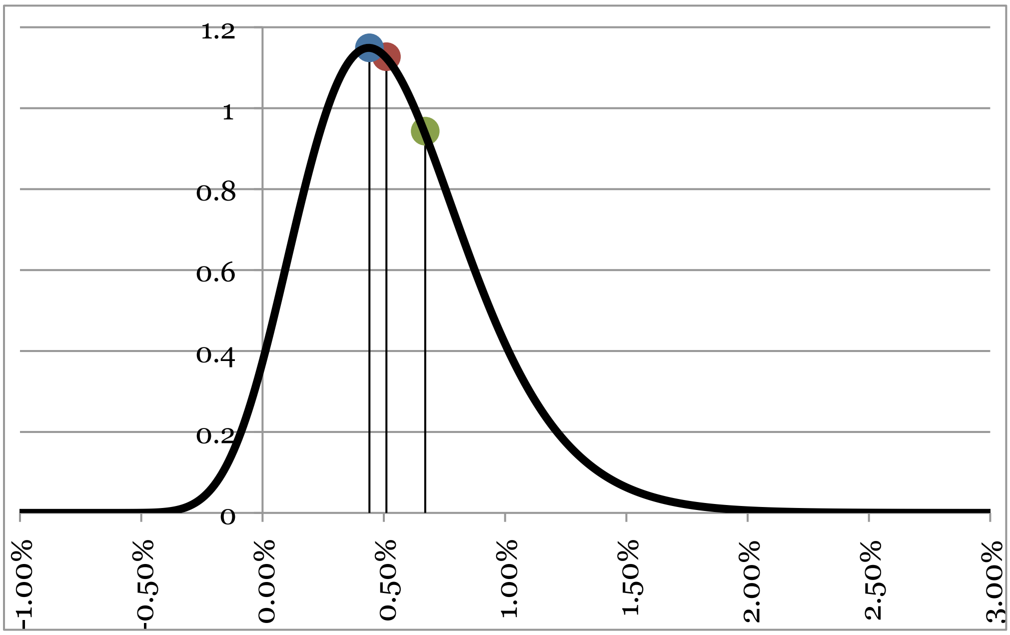

Figure 2. Probability distribution function of the welfare change associated with the condition "to convert one hectare of land to agroforestry" measured as a change in annual interest rate of a loan. Green point is the mean, red is the median, and blue is the mode.

We find that, holding all else equal, the average change in welfare associated with adding the environmental condition to the loan is negative and equivalent to a change in interest rate of just over half a percentage point (mean=0.67%, median=0.51%). As indicated by the choice model results, the welfare for a given household in the population is dependent on their potential loss or gain associated with the environmental condition. Meaning that for nearly 24% of households in the sample, the anticipated welfare change is positive, while for about 8% the welfare change is so large that they would never accept the condition. On average though, the negative change is not of a very large magnitude, the mean corresponds to a change in annual loan repayment of $11.57 based on a $2,500, 4-year loan with a 12% base interest rate.

4.4. Simulating Uptake of CB-PES

Based on the choice model, we can calculate the predicted utility of each alternative to a given respondent and thus simulate the predicted acceptance of each alternative across the population if CB-PES were implemented. Table 5 presents the results of the simulation of a $2,500, 4-year loan where the normal market interest rate for credit is 12%. That rate is the low-end of market rates in areas surrounding the case study area, but is presented here for illustrative purposes and deemed reasonable since it is assumed that measures to ensure credit repayment (whether normal credit or CB-PES) such as joint liability or collateral requirements would be put in place.

Table 5. Results of simulation of CB-PES compared to a baseline interest rate of 12% for normal credit lending.

CB-PES Interest Rate	Uptake of Credit		PES portion of CB-PES		
	CB-PES	Loan w/out condition	$/year	As % of loan repayment	% of PES that compensates for welfare change
12%	22.3%	25.3%	-	-	-
10%	30.8%	23.4%	$34.41	4.2%	8.2%
8%	41.1%	20.9%	$68.28	8.3%	5.6%
6%	52.5%	17.8%	$101.61	12.3%	4.8%
4%	63.7%	14.5%	$134.36	16.3%	4.5%
2%	73.7%	11.2%	$166.53	20.3%	4.3%
0%	81.8%	8.4%	$198.09	24.1%	4.2%

Following the third row of Table 5 where the interest rate for CB-PES is 8%, we find that given this scenario, it is predicted that 62% of the population would accept a loan and 41.1% would accept that loan while agreeing to the environmental condition. Compared to a 12% market rate, the CB-PES 8% interest rate corresponds to a PES payment of $68.28 per year, which would be awarded as a decrease in the amount that the borrower had to repay each year of the loan as long as the environmental condition was being met, in this case that the household had an additional hectare of agroforesty compared to before the loan being given.

There are two key results revealed by the simulation. First, when the CB-PES rate is 8%, the PES payment represents only 8.3% of the total annual loan repayment. Even at lower CB-PES rates (thus higher PES payments), the PES payment always represents a small portion of total loan repayment, meaning that under this scenario, households are willing to take on the majority of the financial burden. Perhaps more strikingly, at a CB-PES rate of 8%, the percentage of the PES payment that represents a compensation for the change in welfare an average household anticipated to experience is only 5.6% of the payment. This means that under this scenario, the PES payment is primarily going towards supporting a household's own desire to carry out the condition. On average across the households willing to participate under these conditions, only $3.79 is considered payment for a decrease in welfare associated with carrying out the environmental condition. Even at lower interest rates, with higher PES payments and thus high rates of acceptance across the population, the proportion of the payment considered compensation for a negative welfare change is a small percentage of the PES payment.

Table 6. Comparing the annual repayment of CB-PES if the condition is met to the repayment required if the condition is not met, expressed in both $/year and as a % of reported 12-month gross cash income. The latter is a mean expected value based only the portion of the population that it is predicted would accept CB-PES at the interest rate given. Based on a $2500, 4-year loan.

CB-PES Rate	Repayment on CB-PES		Repayment on 12% Market Rate	
	$/year	As % of Gross Cash Income	$/year	As % of Gross Cash Income
12%	$823	7.7%	$823	7.7%
10%	$787	10.3%	$823	10.8%
8%	$755	13.3%	$823	14.5%
6%	$721	16.5%	$823	18.8%
4%	$689	19.5%	$823	23.2%
2%	$657	21.8%	$823	27.3%
0%	$625	24.0%	$823	31.6%

A final key consideration is to look further at the debt burden that respondents are hypothetically being asked to take. Table 6 compares the annual repayment that a household would be liable for with CB-PES interest rate ranging from 12% down to 0%. That liability is expressed in both $/year and as a percentage of gross cash income reported for the 12-month period prior to the survey being implemented. Importantly that percentage does not account for the entire population, but is a mean expected value representing only the portion of the population that it is predicted would accept CB-PES at the stated rate.

It would be very important to consider whether or not household were able to handle the liability it is asked to take on. It is difficult from this data to say what an acceptable level of liability is, but an annual repayment of 20-30% of annual income seems reasonable compared to examples where smaller loans (on the scale of $100's, rather than $1,000s) are taken out and repaid multiple times a year in communities with lower average annual income than this case study (Collins et al., 2009). More importantly, the increase in liability if the CB-PES condition is not met, is not very large for most cases. So if a household were deemed able to handle the liability in the first place, then the change associated with the undesirable outcome of not meeting the conditionality generally represents only a few percent of gross annual income. As such, the potential “surprise” liability if the condition were not met does not seem burdensome relative to the total liability a household would be accepting.

5. Discussion

5.1. Summary of Case Study

The Intag River Zone represents a credit-constrained context where an increase in agroforestry, or at least changes in land-use on productive lands, is believed necessary to save the forested area that remains, reverse trends of environmental degradation, and provide increasing levels of biodiversity and ecosystem services that are valuable on local to global scales. Our choice model and simulation results indicate that if CB-PES were implemented, where the WTP by ES buyer is around $100 per hectare per year with a condition of converting one hectare of land to agroforestry, approximately 50% of households would select to sign up to the programme with the reported intent of meeting that condition. That PES payment of around $100 per hectare is somewhat higher than comparable case studies. For example, one case study of PES to promote agroforesty in Nicaragua reported a maximum payment of $75 per hectare for 4 years (Pagiola et al., 2007), while a case study of PES for reforestation in Ecuador reported a range of $40-$60 per hectare annualised over 3 years (Wunder & Albán, 2008). In Intag, at very low interest, up to 80% of the population would accept CB-PES, but even at these high acceptance rates each household would assume more than ¾ of the burden of loan repayment. Most interestingly, under any reasonable scenario the compensation for the (on average) negative welfare change associated with meeting the condition is a small proportion of the total PES reward.

5.2. Implementing CB-PES

The case study analysed here illuminated the dynamics of CB-PES and highlights key considerations of its implementation. First, as with any incentive scheme, the uptake will be dependent (at least in part) on the magnitude of the value of the incentive. As the PES payment within CB-PES increases, so does the predicted uptake of CB-PES increase. What is more important, however, is that both the cost and uptake are sensitive to the reference market rate for credit. Any conservation organisation wanting to explore CB-PES would have to determine what the appropriate and/or feasible reference market rate is before being able to understand the cost of such a programme and willingness of households to participate.

Our case study and model also illustrate that the decision of an individual household to participate in CB-PES is dependent on their expected loss or gain associated with carrying out the environmental condition. In potential CB-PES cases where the condition is related to a joint production activity, targeting may not be necessary. In other cases, however, targeting may be required to improve the environmental performance of a programme, as is true with any PES programme (Wünscher et al., 2008). As is also the case with most PES, there is a self-selection process, where those that have the lowest cost associated with the condition (and perhaps even a gain) would choose to participate. In the case of CB-PES, however, this doesn't mean they have a greater direct profit, it more precisely means that the self-selectors would be willing to pay a higher interest rate and accept the same condition on a loan as those that are more reluctant to accept a conditional loan. The ideal for PES is to have heterogeneous contracts and pay each household based on its opportunity costs. That is difficult in the practice of PES, but perhaps there is some hope for CB-PES, however, that the contract process is easier to tailor to the individual household and so more heterogeneous rewards may be feasible.

The payment in this case seems higher than other comparable PES cases. If heterogeneous CB-PES contracts are feasible, borrowers willing to accept a higher interest rate for CB-PES could cross-subsidise those requiring a lower interest rate to participate. An external solution may be to carry out CB-PES in partnership with development funders. Access to affordable credit is considered a development issue and CB-PES is clearly an incentive mechanism with dual environmental and developmental objectives. It would be logical to ask two sets of funders to pay for the two different benefits.

That also relates to a question of what level of conditionality is appropriate. Remember, the mechanism through which this incentive works is that if the condition is met, households have to pay back less than the market rate, if they don't meet it, however, they have to pay back the normal market rate. If the proposed PES reward is large, more households will be interested in accepting CB-PES with the reported intent of meeting the condition, but will they be able to pay back the market rate if the condition is not met? In this case the level of payback seems reasonable, but clearly safeguards and checks would need to be in place to ensure no household is taking on a debt burden they could not afford. Further, it suggests that the reward (in the form of lower repayments) may be better as a partially conditional reward in order to be supportive of relatively lower-income households participating but not taking on too much debt burden. For example, if the reward were a reduction in annual repayments of $100, perhaps $50 would be unconditional and simply reward the attempt to meet the condition, while $50 would be wholly conditional. Or put another way, $50 would be considered paying for developmental benefits of access to affordable credit, while $50 would be considered paying for the delivery of ecosystem services.

Additionally, in any of the reasonable scenarios in this case study, a failure to meet the environmental condition would not drastically increase the annualised debt burden. In other cases, however, this may or may not be true, and will depend on the size of loans offered and the income level of the borrowers/ES providers. It would be important for any implementer of CB-PES to understand both the potential total debt burden a household was taking on, and the change in that burden that could occur if the condition is not met.

5.3. CB-PES as Incentive

The case of Intag does not allow a direct comparison between CB-PES and direct PES. It does, however, illuminate a few interesting points. The key result is that CB-PES clearly fits the precondition of a good incentive as proposed from behavioural sciences. Under any reasonable scenario, potential ES providers report that they are willing to take on the majority of the burden of loan repayment and only a small proportion of the CB-PES reward is considered compensation for a negative welfare change associated with meeting the environmental condition. CB-PES is thus clearly an incentive that potential ES providers would perceive as *supportive*, rather than *controlling* (Frey & Jegen, 2001). Related to that, it clearly fits the paradigms of PES as co-investment (Van Noordwijk & Leimona, 2010) or a more reciprocal arrangement (Farley & Costanza, 2010) that PES academics and practitioners are increasingly considering the best ways to frame PES, particularly in a developing country context. Further, because the reward is time constrained and is really a reward that lowers a burden, rather than increases a payment, it is less likely to induce entitlement among ES providers, which is a concern of direct PES highlighted by ecological and institutional economists (Farley & Costanza, 2010; Vatn, 2010). Finally, CB-PES is inherently designed to support both environment and development objectives, rather than create trade-offs (Groom & Palmer, 2010), which is something that all stakeholder should prefer.

6. Conclusion

More empirical research and pilot projects with well-monitored outcomes need to be carried out to answer all of the questions remaining about the use of credit-based payments for ecosystem services. The stated preference study presented here, however, provides some interesting lessons. In terms of design, the uptake and cost of CB-PES will depend greatly on the reference market interest rate and the expected loss or gain associated with the environmental conditionality. In terms of implementation, particular attention should be paid to the debt burden a potential ES provider may be attempting to take on, and safeguards and checks should be put in place to ensure no household takes on too much debt. Perhaps, even a partial conditionality should be implemented; where a portion of the reward is unconditional and considered “for development” while a portion is conditional and considered “for environment”. Above all, however, CB-PES clearly fits certain criteria that are believed to make for good incentives and are increasingly discussed in the PES literature. As such, it is wholly recommended that the concept should be explored further and piloted beyond the few examples of convertible lending, which, notably, have seen success.

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